Health Consultation

Residential Vapor Intrusion Investigation

FORMER HARDESTY FEDERAL COMPLEX

KANSAS CITY, MISSOURI

Prepared by
Missouri Department of Health and Senior Services

JULY 11, 2016

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Community Health Investigations
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

A health consultation is a verbal or written response from ATSDR or ATSDR's Cooperative Agreement Partners to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR or ATSDR's Cooperative Agreement Partner which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Prepared By:

Missouri Department of Health and Senior Services
Division of Community and Public Health
Section for Environmental Public Health
Bureau of Environmental Epidemiology
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

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SUMMARY

Introduction	The Missouri Department of Health and Senior Services (MDHSS), in cooperation with the federal Agency for Toxic Substances and Disease Registry (ATSDR), has developed this health consultation to evaluate the potential health impacts of exposure to volatile organic compounds (VOCs) in indoor air at residences and other occupied buildings near the former Hardesty Federal Complex site in Kansas City, Missouri (MO). The detection of trichloroethylene (TCE) and other chlorinated VOCs in groundwater at the former Hardesty Federal Complex has prompted concerns that individuals in the surrounding neighborhood may be breathing those VOCs, which may volatilize from groundwater, migrate into buildings, and accumulate in indoor air to levels of potential health concern as a result of vapor intrusion. In August-October 2014, the United States General Services Administration (GSA) in coordination with the Missouri Department of Natural Resources (MDNR) conducted initial vapor intrusion (VI) sampling at two homes thought to be in the path of the groundwater contamination. In this health consultation, MDHSS has reviewed the results of that limited investigation and has made recommendations for an expanded VI investigation.
Conclusions	MDHSS has reached two important conclusions:
Conclusion 1	In the past, breathing TCE in indoor air may have posed increased health risks in two residences northeast of the former Hardesty Federal Complex site. Of particular concern are the increased risks of fetal heart malformations from TCE exposure during the weeks in the first trimester of pregnancy that the heart is developing. Due to recent remedial actions at the two sampled residences, vapor intrusion is not expected to pose current or future health risks at those residences. However, because of a lack of sampling data, past, current, and future health risks of possible short-term TCE exposure at other residences or occupied building in the neighborhood are not known.
Basis for Conclusion 1	TCE concentrations in indoor air were found to exceed health-based screening levels at two residences northeast of the site. Those screening levels are based on several animal and epidemiological studies that have provided evidence that exposure to low concentrations of TCE may increase the risk of gestational or early postnatal development of cardiac malformations. A mother's exposure to TCE during the 3 week period of critical heart formation in the first trimester of pregnancy could result in an increased risk of a heart defect in the baby. TCE concentrations

	in indoor air at both residences approached a human equivalent concentration (HEC) associated with potential fetal heart defects (21 µg/m^3). Soon thereafter, mitigation actions were completed at both residences to reduce TCE migration into the basements of those homes. A VI mitigation system was installed at one residence where TCE was found to be elevated in subslab soil gas. Floor drain traps were plugged at the other residence where TCE vapors had seeped into the sewer line. If the sampling results are representative of TCE concentrations in indoor air at other homes and occupied buildings in the neighborhood, TCE may pose past, current, and/or future health risks to other individuals. Indoor air and subslab soil gas samples have not been collected at other residences or occupied buildings in the neighborhood.
Conclusion 2	MDHSS cannot conclude whether chronic (long-term) exposure to TCE in indoor air at residences or other occupied buildings near the former Hardesty Federal Complex may harm people's health, as indoor air sampling has only occurred at two residences northeast of the site over a limited time period. Potential health impacts of long-term exposure to TCE include adverse effects on the immune system and kidneys, which could result from several months or more of breathing a sufficient dose of TCE in adults and children, and increased cancer risks from a lifetime of exposure to TCE.
Basis for Conclusion 2	TCE concentrations in indoor air at the two sampled residences northeast of the site approached an HEC associated with potential kidney effects from long-term exposure (30 µg/m^3). TCE concentrations were below an HEC associated with immunological effects from long-term exposure, although concentrations were within the range of uncertainty attributed to those effects (1.9 – 190 µg/m^3). Long-term concentrations of TCE in indoor air at those residences are not known, however, as they likely fluctuate over time. Indoor air and subslab soil gas samples have not been collected at other residences or occupied buildings in the neighborhood.
Recommendations	MDHSS recommends that concerned parents seek medical advice about the possibility of heart malformations in their newborn children if, during pregnancy, TCE concentrations in their indoor air are found to exceed a level of health concern.

	MDHSS recommends sampling at additional residences and occupied buildings in the area in a systematic effort to swiftly determine the extent of TCE vapor migration and intrusion in the neighborhood and whether TCE is currently posing health risks at those locations. MDHSS recommends quickly reducing exposures to TCE at other residences or occupied buildings, if additional VI sampling indicates TCE concentrations pose current or future health risks at those locations. MDHSS recommends full characterization of groundwater contamination at the site to determine the extent of migration of TCE and other potential contaminants from the source zone(s). MDHSS recommends continued monitoring and maintenance of implemented controls until the source of VOCs is attenuated or remediated to below screening levels or until buildings are no longer susceptible to vapor intrusion.
Next Steps	MDHSS will continue to coordinate with GSA, MDNR, or other agencies in reaching out to the community to educate people on the adverse health effects of VOC exposures in the hopes that GSA, MDNR, or other agencies will gain access for VI sampling in other potentially-impacted homes or occupied buildings in the community. MDHSS will coordinate with ATSDR, GSA, MDNR, or other agencies to notify the community of the findings of this health consultation and address community health concerns and questions as requested. As requested, MDHSS will review and comment on any additional data from environmental samples collected by GSA, MDNR, or other agencies as they become available.

FOR MORE INFORMATION

If you have concerns about your health or information in this report, you can contact the Missouri Department of Health and Senior Services at 1-866-628-9891. You may also call ATSDR at 1-800-CDC-INFO and ask for information on the former Hardesty Federal Complex site.

PURPOSE AND HEALTH ISSUES

The Missouri Department of Health and Senior Services (MDHSS), in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR), has developed this health consultation to evaluate the potential public health impacts of exposure to volatile organic compounds (VOCs) in indoor air at residences and other occupied buildings near the former Hardesty Federal Complex site in Kansas City, Missouri (MO). This public health evaluation was performed at the request of the Missouri Department of Natural Resources (MDNR). ATSDR is a federal agency within the United States (U.S.) Department of Health and Human Services and is authorized by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) to conduct public health assessments at hazardous waste sites. The top priority of MDHSS in performing this evaluation is to provide individuals living or working near the site with the best information possible to safeguard their health.

SITE DESCRIPTION AND BACKGROUND

The former Hardesty Federal Complex site is located at 607 Hardesty Avenue in Kansas City, MO. The site consists of multiple buildings on approximately 18 acres of commercial/light industrial property located on the southeast corner of Hardesty Avenue and East Independence Avenue [Terracon 2013]. Residential, commercial, and light industrial areas surround the site.

During World War II and start of the Cold War era, the site of the complex served as the Kansas City Quartermaster Depot, where U.S. Army clothing and equipment were purchased, stored, and shipped. Military uniforms were also laundered and treated with an unknown mixture of chemicals to increase their resistance to warfare gases, such as "mustard gas" [Terracon 2013]. Some chemicals stored on the site at that time (e.g., petroleum and cleaning solvents) were stored in underground storage tanks, which over time began to leak into the soil and groundwater. Chemicals were also reportedly stored in tanks housed in concrete pits.

In 1960, ownership of the site was transferred to the U.S. General Services Administration (GSA), who recently sold much of the site to the Hardesty Renaissance Economic Development Corporation. Although the site is now under private ownership, GSA, in coordination with MDNR, has maintained oversight of the environmental investigation of the site and cleanup of contaminants related to past activities at the site.

In a preliminary assessment of environmental contamination at the site conducted in 2002, chlorinated VOCs were detected in soil and shallow groundwater up to the northeast boundary of the site [Terracon 2013]. Targeted chlorinated compounds included tetrachloroethylene (PCE), tetrachloroethane (PCA), trichloroethane (TCA), trichloroethylene (TCE), and dichloroethene (DCE). The sampling results indicated that

chlorinated VOCs released into soil and groundwater near the former clothing renovation building had traveled at least to the boundary of the site in the direction of groundwater flow to the east-northeast [Terracon 2013]. In 2003, following the onsite assessment, GSA, in coordination with MDNR, performed an initial investigation of offsite contaminant migration. In the offsite sampling performed in a residential area northeast of the site, TCE was found to be a contaminant in deep groundwater [Terracon 2013]. Residences surrounding the site are connected to the public water supplied by the Kansas City Missouri Water Supply Department, which obtains water from the Missouri River [Terracon 2013]. Therefore, residents are not at risk of exposure to TCE from the site through the public drinking water supply.

In 2010-2011, in an expanded offsite investigation, TCE was detected in shallow and deep groundwater collected from some monitoring wells northeast of the site. TCE concentrations were as high as 7.6 µg/L in shallow groundwater and 274 µg/L in deep groundwater collected from offsite wells [Terracon 2013]. Although TCE concentrations at several sampling locations were below laboratory detection limits, and although detected TCE concentrations were higher in deep groundwater than in shallow groundwater, those limited findings indicated a potential for offsite TCE vapor intrusion (VI). In a VI exposure pathway, VOCs volatilize from soil and groundwater and travel into homes and other buildings, where they may accumulate to levels of potential health concern.

In 2014, GSA, in coordination with MDNR, conducted VI sampling at two residences in the neighborhood northeast of the site. The results of that initial offsite VI investigation are discussed in this health consultation. Since that time, GSA and MDNR have sought to expand off-site VI sampling to include additional properties, particularly residences northeast of the site but also properties east and southeast of the site that recent environmental investigations indicate could also be at risk of vapor intrusion.

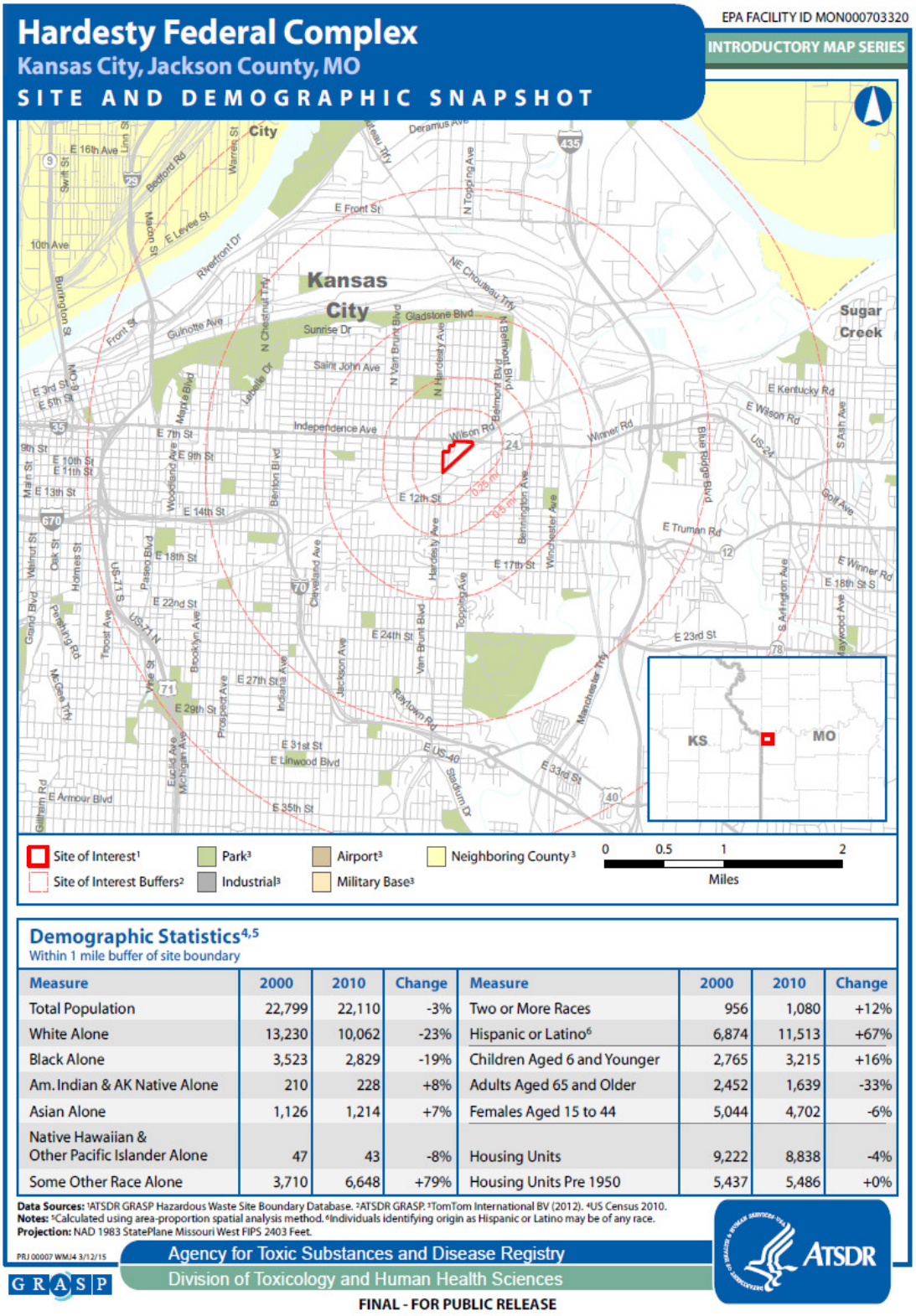
Demographics

According to the 2010 U.S. Census, 22,110 people live within a one mile radius of the former Hardesty Federal Complex. Within that radius, approximately 45% are white, 13% are African American, 5% are Asian, and 37% are other races. Approximately 45% of the population identified themselves as Hispanic or Latino. Map 1 shows detailed demographic information on the area surrounding the site.

As shown in Appendix A (Map A-1), populations surrounding the site fall within the top 25% of the 2010 social vulnerability index. The social vulnerability index is used to identify populations that may be especially vulnerable to developing adverse health effects from the release of chemicals from hazardous waste sites. Increased vulnerability may be due to factors such as cultural or language barriers that may limit a person's access to the benefits of public health outreach efforts. It is measured by socioeconomic status, family composition, race/ethnicity/language, and housing/transportation access. According to the 2010 U.S. Census, 30.2% of the population living in Zip Code 64123,

including the neighborhood northeast of the site, speak languages other than English at home [U.S. Census Bureau 2010].

As shown in Appendix A (Map A-2), approximately 22% of the population living within a 1-mile radius of the site are females aged 15-44 years. It is especially important to prevent TCE exposure in women of child-bearing age, because of the potential susceptibility of a fetus to adverse health effects from short-term TCE exposures.



Map 1. Demographic statistics within a 1 mile radius of the former Hardesty Federal Complex site.

DISCUSSION

Vapor Intrusion Pathway

If VOCs are released into the soil and groundwater at a site, they can travel offsite as a groundwater and/or soil gas contaminant [EPA 2015; ITRC 2007]. VOCs in soil gas that comes in close proximity to residences and commercial buildings may travel through cracks in the foundation or other conduits and accumulate in indoor air. If VOCs accumulate in indoor air to levels of potential health concern, breathing those VOCs even for short periods of time could pose adverse health risks.

Rates of vapor intrusion into indoor air can vary significantly, depending on the site geology, building construction, and the presence of cracks in building foundations [EPA 2015; ITRC 2007]. VI investigations are complicated by the potential for VOCs to travel by various pathways and by the tendency for the rates of vapor intrusion to differ even in neighboring homes. Identification of complete VI pathways of exposure generally requires a "multiple lines of evidence" approach, involving collection of groundwater, soil gas, indoor air, subslab soil gas, and/or crawl space air samples. Household or workplace chemicals containing VOCs can also contribute to concentrations measured in indoor air. The VI pathway is considered to be complete if VOC concentrations in indoor air are attributed to VOCs in soil gas or shallow groundwater.

Residential Sampling Results

From August to October 2014, GSA and MDNR in consultation with MDHSS conducted a VI investigation at residences near the former Hardesty Federal Complex. Indoor air and subslab soil gas samples were collected at two homes located northeast of the site. Table 1 shows a summary of the results of that investigation. At both residences, TCE was detected in indoor air. Other chlorinated VOCs were not detected in either indoor air or subslab soil gas samples.

At one residence, TCE in indoor air was attributed to intrusion of TCE vapors into the sewer line. In the initial round of sampling, TCE in indoor air at that residence exceeded health-based screening levels, while TCE in subslab soil gas was relatively low. The source of TCE in the indoor air at that residence was not evident until traps in two floor drains were plugged to prevent the transport of vapors from the sewer line into the basement of the house. In a second round of VI sampling, after floor drains were plugged, TCE concentrations in the basement fell below health-based screening levels.

At the other residence, TCE in indoor air was attributed to the migration of subsurface soil gas vapors through the basement foundation. TCE concentrations in indoor air at that residence were initially below health-based screening levels. However, TCE in subslab soil gas concentrations exceeded a screening level by approximately 10-times, indicating a potential for vapor intrusion at that residence. In a second round of VI sampling, TCE concentrations in indoor air were found to exceed health-based screening

levels, apparently as a result of the "stack effect" (i.e., increased rates of vapor intrusion that accompanies a change in indoor air pressure when heating systems are in use). A VI mitigation system was installed at that residence to reduce/prevent future vapor intrusion of subslab soil gas into the indoor air.

Table 1. Trichloroethylene in Residential Air and Soil Gas Samples
Former Hardesty Federal Complex Site, Kansas City, Missouri
August - October 2014

Location	Sample Type[a] (9 samples)	Range of TCE Concentrations[b] ($\mu g/m^3$)	Health-Based Screening Levels[c] ($\mu g/m^3$)	Exceeded Screening Level?
Residence 1	Indoor Air (2)	2.1 – 11.0	2.1 (noncancer) 0.24 (cancer)	Yes
	Subslab Soil Gas (1)	0.8	70 (noncancer)	No
Residence 2	Indoor Air (4)	0.1 – 7.3	2.1 (noncancer) 0.24 (cancer)	Yes
	Subslab Soil Gas (2)	680 – 1,600	70 (noncancer)	Yes

[a]Number of samples shown in parentheses collected prior to VI mitigation
[b]Concentrations detected prior to VI mitigation.
[c]Indoor air screening levels are ATSDR's minimum risk levels (MRLs) for screening of noncancer health risks from intermediate and chronic exposures to TCE and ATSDR's cancer risk evaluation guide (CREG) for screening of cancer risks of lifetime exposure to TCE. The subslab screening level is derived from the noncancer indoor air screening level using EPA's default attenuation factor of 0.03 [EPA 2015].

Additional Sampling in the Surrounding Community

Residences and other buildings northeast, east, and southeast of the site are considered to be at potential risk of vapor intrusion. GSA, MDNR, and other agencies have made multiple attempts to notify neighbors of the need for additional VI investigations, including attempts by mail and door-to-door visits. However, GSA and MDNR have yet to gain access to additional properties for VI sampling. MDHSS will assist other agencies, as requested, to reach out to the community and communicate the findings of this health consultation to encourage their participation in the VI investigations.

In addition to participating in door-to-door visits, MDHSS, MDNR, the Kansas City Health Department, and other agencies have attended public availability sessions hosted by GSA to discuss planned sampling activities and potential health concerns with local residents. Public availability sessions were held on 6/20/13, 12/5/13, 10/29/14, and 11/17/15 at the North-East Branch of the Kansas City Public Library. Spanish and

Vietnamese interpreters have been available to assist members of the public who speak those languages commonly used in the neighborhood. GSA also has developed educational materials including newsletters and site update fact sheets in various languages, including Spanish, Somali, and Vietnamese.

PUBLIC HEALTH IMPLICATIONS

The health risks of exposure to environmental contaminants are initially evaluated by comparison of the concentrations of those contaminants to health-based guidelines established by ATSDR, EPA, and other agencies. Screening levels developed by ATSDR include minimal risk levels (MRLs), which are estimates of acute (< 2 weeks), intermediate (2 weeks to <1 year), and chronic (>1 year) exposure not likely to result in adverse, non-cancer health effects. Screening levels developed by other agencies include EPA's reference concentrations (RfCs), which are inhalation exposure levels unlikely to cause non-cancer effects in humans over a lifetime. ATSDR's cancer risk evaluation guides (CREGs) are used in assessing the risks of exposure to known or potential carcinogens.

Contaminant concentrations that exceed screening level values do not necessarily pose health risks. Several factors determine whether individuals will develop adverse health effects, including age, health and nutritional status, and the amount and length of time of exposure. In this section, the potential health impacts of exposure to TCE in indoor air at the sampled residences northeast of the Hardesty site are further evaluated.

Non-Cancer Effects

In 2011, EPA developed a noncancer screening level for TCE from studies showing development of cardiac malformations in rats over approximately three weeks of gestational exposure to TCE, and immunological effects in mice after 30 weeks of exposure to TCE [EPA 2011]. In its review of those studies, EPA derived TCE concentrations in air that might be expected to have the same effects in humans. Human equivalent concentrations (HECs) are 21 $\mu g/m^3$ TCE for short-term exposures potentially associated with cardiac malformations and 190 $\mu g/m^3$ TCE for chronic exposures potentially associated with immunological effects [EPA 2011].

Based on EPA's evaluation of those studies, ATSDR established an MRL for chronic (>1 year) inhalation exposure to TCE (2.1 $\mu g/m^3$) [ATSDR 2013]. Because of TCE's potential effects on fetal heart development with short-term exposures, ATSDR has also applied that screening level to intermediate (2 weeks to <1 year) inhalation exposure.

While there are limitations to the animal study that demonstrates the potential for cardiac malformations and serves as a basis for EPA's RfC and ATSDR's MRLs, the results of that study are believed to be supported by the general weight of evidence from multiple epidemiological and other studies that maternal exposure to TCE may cause a variety of congenital cardiac defects [Chiu 2012]. In addition to the heart of a developing fetus, the

most sensitive targets of TCE exposure appear to be the kidneys and immune system [EPA 2011]. Immunological studies, including epidemiological studies, indicate that chronic exposure to a sufficient dose of TCE may increase the risk of development of autoimmune diseases and hypersensitivity skin disorder, as well as possible suppression of the immune system [Chiu 2012]. These include inflammatory diseases and scleroderma, a hardening of the skin. There is also substantial evidence that, at sufficient dose and exposure duration, TCE is toxic to the nervous system, kidney, liver, and male reproductive system and is associated with other developmental effects [ATSDR 2013].

At both sampled residences northeast of the Hardesty site, maximum TCE concentrations in indoor air prior to VI mitigation (7.3 $\mu g/m^3$ and 11 $\mu g/m^3$) approached the estimated HEC for fetal cardiac malformations (21 $\mu g/m^3$). As TCE concentrations in indoor air likely fluctuate, past TCE concentrations in indoor air could have exceeded the HEC. As a result, DHSS concludes that breathing TCE in indoor air at those residences may have increased the risks of fetal heart malformations. A mother's exposure to TCE during the three week period of critical heart formation in the first trimester of pregnancy could result in an increased risk of a heart defect in the baby.

At both sampled residences, maximum TCE concentrations fell within a range of uncertainty applied to the HEC for immunological effects (i.e., from 1.9 $\mu g/m^3$ to 190 $\mu g/m^3$). In addition, maximum TCE concentrations approached the concentration associated with adverse kidney effects (30 $\mu g/m^3$) that EPA used to support establishment its screening level [EPA 2011]. As TCE concentrations in indoor air likely fluctuated, long-term TCE concentrations in indoor air could have approached or exceeded HECs. Potential long-term exposure concerns include adverse effects on the kidneys and immune system in adults and children. Since indoor air sampling only occurred over a limited time period, MDHSS cannot draw more definite conclusions about potential health concerns due to chronic (long-term) exposures.

Estimated Cancer Risks

Cancer is very common. The American Cancer Society estimates that nearly half of men and slightly more than a third of women in the United States will develop some form of cancer in their lifetimes [Siegel et al 2016]. Thus, estimates of cancer risk from chemical exposure are referred to as "increased risk" estimates. There are multiple types of cancer that have different risk factors and affect different organs.

EPA classifies TCE as carcinogenic to humans. The National Toxicology Program (NTP) has determined that TCE is reasonably anticipated to be a human carcinogen, based on evidence from animal studies and limited evidence from human studies [NTP 2011]. Long-term TCE exposure is associated with liver and kidney cancers and non-Hodgkins lymphoma by multiple routes, including inhalation exposure [EPA 2011; ATSDR 2013]. Because kidney cancer may develop by a mutagenic mode of action from exposure to TCE, children may be especially susceptible to TCE's carcinogenic effects. It is possible that increased cancer risks from breathing TCE could be somewhat higher if exposures occur during childhood [EPA 2011; ATSDR 2013].

In this health consultation, cancer risk was estimated from the highest TCE concentration detected in residential indoor air prior to VI mitigation, using EPA's Age-Dependent Adjustment Factors (ADAFs) to account for increased early-life susceptibility to kidney cancer [EPA 2011]. Shown in Table 2 is an estimate of increased cancer risk that assumes residents might continuously breathe TCE in indoor air over a lifetime (see calculations in Appendix B). The estimated value represents, at most, 5 additional cancer cases in a population of 100,000 people exposed to the same TCE concentration over a lifetime.

Table 2. Potential Increase in Cancer Rates from Lifetime Exposure to Trichloroethylene in Sampled Residences
Former Hardesty Federal Complex Site, Kansas City, Missouri

	Maximum Cancer Risk Value[a]	Potential Increase in Cancer Rates
TCE	5.2×10^{-5}	**5 additional cases per 100,000 people**

[a]Based on the maximum concentration detected in indoor air prior to VI mitigation

The value in Table 2 is a rough estimate based on limited sampling results. Because it is likely that residents are actually breathing the indoor air in their homes for less than 24-hours/7-days per week over a lifetime, increased cancer risks from breathing TCE could be lower than the estimated value. Also, because long-term exposure levels in the homes and occupied buildings surrounding the site are not known, increased cancer risks from breathing TCE could be significantly higher or lower than the estimated value. Without long-term data, MDHSS cannot draw more definite conclusions about cancer risks in the populations surrounding the former Hardesty Federal Complex site.

LIMITATIONS

MDHSS has identified the following limitations to assessing the public health risks of vapor intrusion in homes and other occupied buildings in the neighborhood surrounding the Hardesty property:

- The VI investigation has so far been limited to two homes located northeast of the Hardesty site. However, groundwater sampling, in addition to the results of this VI investigation, suggest that vapor intrusion may be occurring in many homes and occupied buildings in the neighborhood surrounding the site. MDNR and GSA have not been able to gain access to other homes or occupied buildings for VI sampling.

- Because long-term average concentrations of TCE in indoor air are not known, MDHSS is unable to draw definite conclusions about the health risks of long-term exposure to TCE in indoor air.

CONCLUSIONS

1. In the past, breathing TCE in indoor air may have posed increased health risks in two residences northeast of the former Hardesty Federal Complex site. Of particular concern are the increased risks of fetal heart malformations from TCE exposure during the weeks in the first trimester of pregnancy that the heart is developing. Due to recent remedial actions at the two sampled residences, vapor intrusion is not expected to pose current or future health risks at those residences. However, because of a lack of environmental sampling data, past, current, and future health risks of possible short-term TCE exposure at other residences or occupied building in the neighborhood are not known.

2. MDHSS cannot conclude whether chronic (long-term) exposure to TCE in indoor air at residences or other occupied buildings near the former Hardesty Federal Complex may harm people's health, as indoor air sampling has only occurred at two residences northeast of the site over a limited time period. Potential health impacts of long-term exposure to TCE include adverse effects on the immune system and kidneys, which could result from several months or more of breathing a sufficient dose of TCE in adults and children, and increased cancer risks from a lifetime of exposure to TCE.

RECOMMENDATIONS

1. MDHSS recommends that concerned parents seek medical advice about the possibility of heart malformations in their newborn children if, during pregnancy, TCE concentrations in their indoor air are found to exceed a level of health concern.

2. MDHSS recommends sampling at additional residences and occupied buildings in the area in a systematic effort to swiftly determine the extent of TCE vapor migration and intrusion in the neighborhood and whether TCE is currently posing health risks at those locations.

3. MDHSS recommends quickly reducing exposures to TCE at other residences or occupied buildings, if additional VI sampling indicates TCE concentrations pose current or future health risks at those locations.

4. MDHSS recommends full characterization of groundwater contamination at the site to determine the extent of migration of TCE and other potential contaminants from the source zone(s).

5. MDHSS recommends continued monitoring and maintenance of implemented controls until the source of VOCs is attenuated or remediated to below screening levels or until buildings are no longer susceptible to vapor intrusion.

PUBLIC HEALTH ACTION PLAN

The Public Health Action Plan (PHAP) for the former Hardesty Federal Complex site contains a description of future actions by MDHSS, ATSDR, and other stakeholders. The purpose of the PHAP is to ensure that this public health consultation not only identifies public health hazards, but provides an action plan to prevent adverse human health effects resulting from past, present, and future exposures to hazardous substances at or near the site. Below is a list of commitments of public health actions by MDHSS:

1. MDHSS will continue to coordinate with GSA, MDNR, or other agencies in reaching out to the community to educate people on the adverse health effects of VOC exposures in the hopes that GSA, MDNR, or other agencies will gain access for VI sampling in other potentially-impacted homes or occupied buildings in the community.

2. MDHSS will coordinate with ATSDR, GSA, MDNR, or other agencies to notify the community of the findings of this health consultation and address community health concerns and questions as requested.

3. As requested, MDHSS will review and comment on additional data from environmental samples collected by GSA, MDNR, or other agencies as they become available.

REPORT PREPARATION

This Health Consultation for the former Hardesty Federal Complex site was prepared by the Missouri Department of Health and Senior Services under a cooperative agreement with ATSDR. It is in accordance with the approved agency methods, policies, and procedures existing at the date of publication. Editorial review was completed by the cooperative agreement partner. ATSDR has reviewed this document and concurs with its findings based on the information presented.

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REFERENCES

[ATSDR] Agency for Toxic Substances and Disease Registry. 2013. Addendum to the Toxicological Profile for Trichloroethylene (TCE). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. Available online at http://www.atsdr.cdc.gov/toxprofiles/tce_addendum.pdf

Chiu, W.A. et al. 2012. Human Health Effects of Trichloroethylene: Key Findings and Scientific Issues. Environmental Health Perspectives. National Institute of Environmental Health Sciences, U.S. Department of Health and Human Services.

[EPA] U.S. Environmental Protection Agency. 2011. Toxicological Review of Trichloroethylene: In Support of Summary Information on the Integrated Risk Information System (IRIS). Environmental Protection Agency. EPA/635/R-09/011F.

[EPA] U. S. Environmental Protection Agency. 2015. OWSER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air. Office of Solid Waste and Emergency Response. OWSER Publication No.: 9200.2-154.

[ITRC] Interstate Technology & Regulatory Council. 2007. Vapor Intrusion Pathway: A Practical Guideline. VI-1. Washington, D.C.: Interstate Technology & Regulatory Council, Vapor Intrusion Team. Available online at: www.itrcweb.org

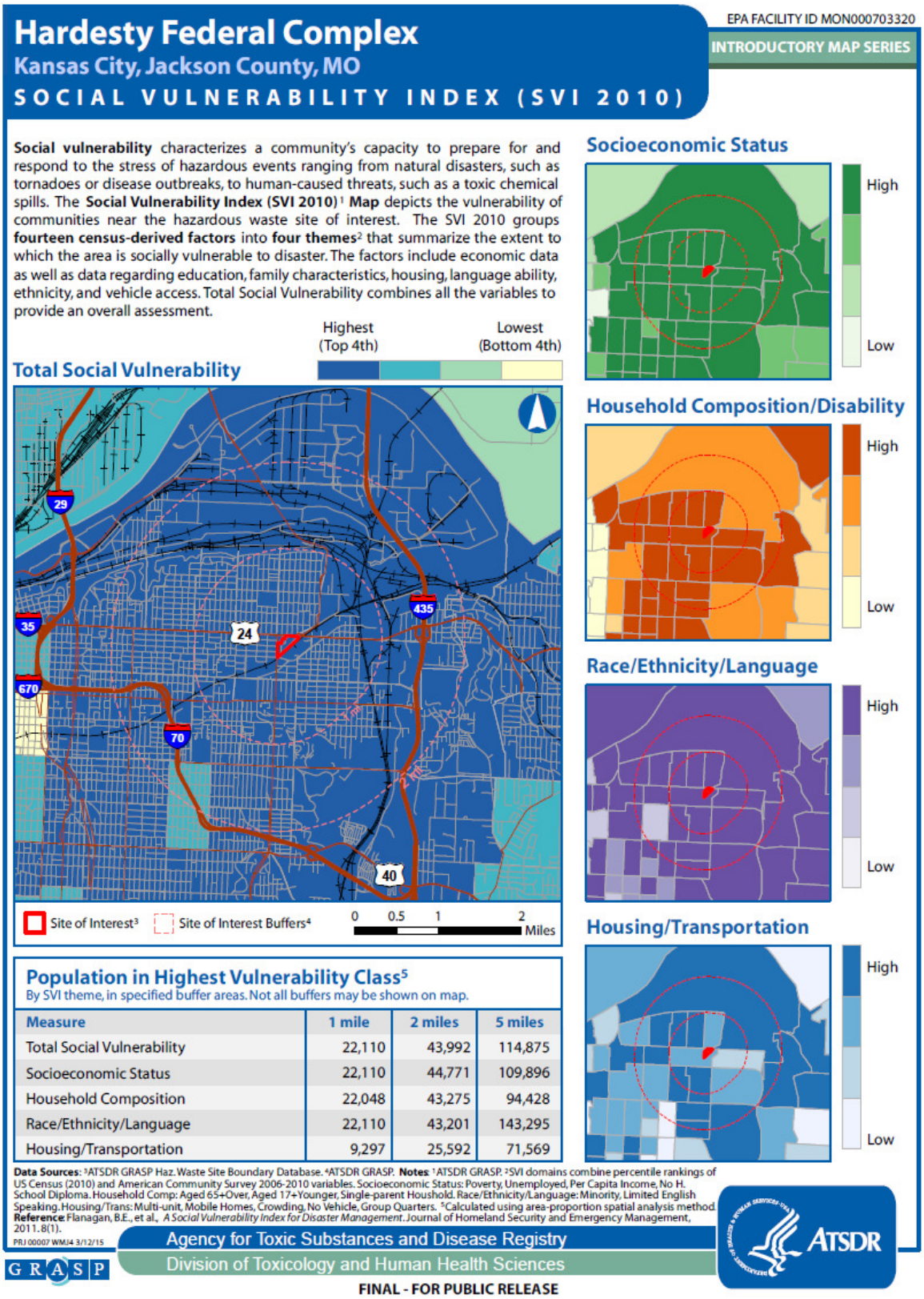
[NTP] National Toxicology Program. 2011. Report on carcinogens, 12th edition. Research Triangle Park, NC: U.S. Department of Health and Human Services, Public Health Service, National Toxicology Program. 499 pp.

Siegel RL et al. 2016. Cancer statistics, 2016. CA Cancer J. Clin. Available online at: www.cancer.org

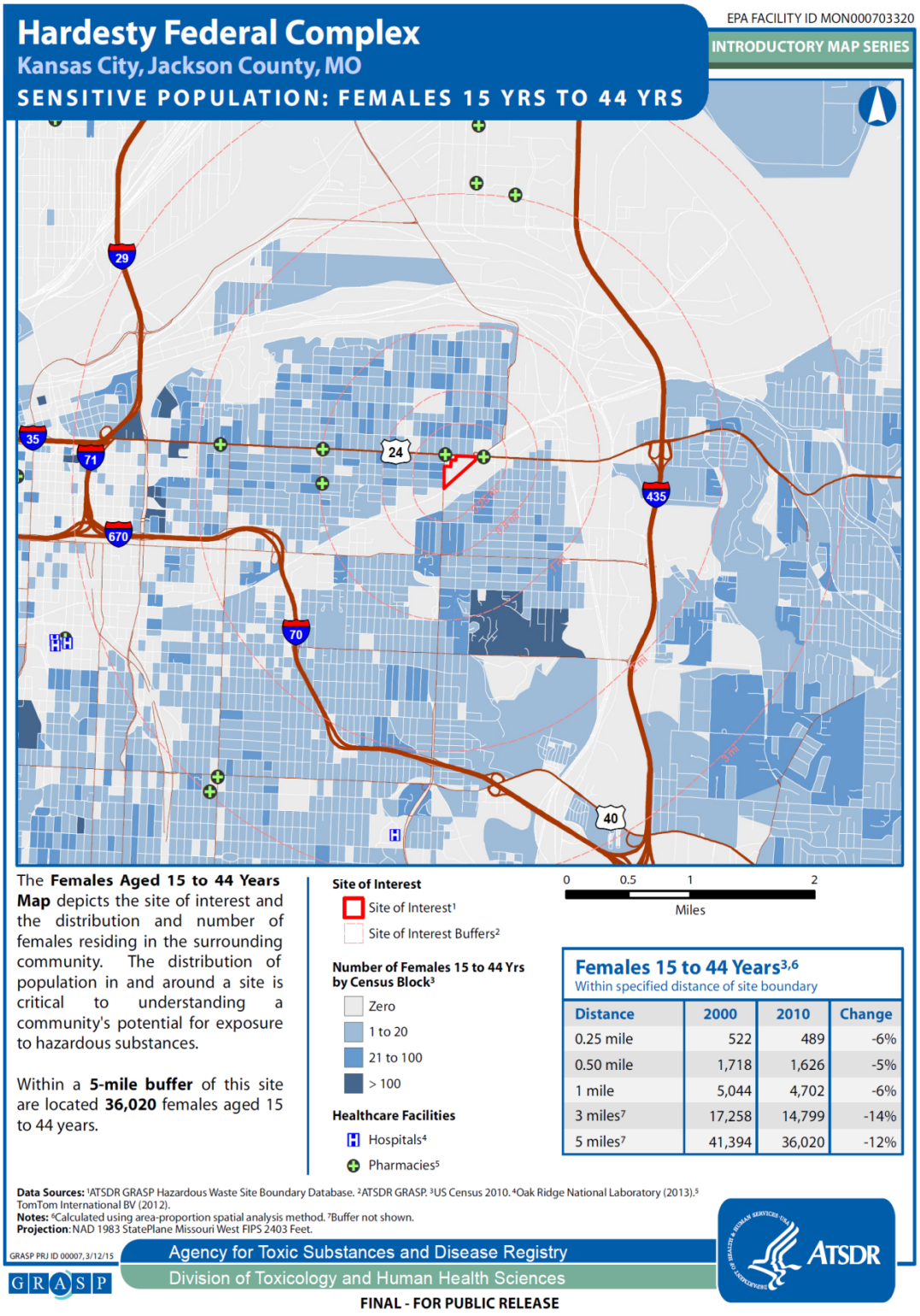
Terracon Consultants, Inc. 2013. Remedial Investigation/Feasibility Study Work Plan, Hardesty Federal Complex. Prepared for the United States General Services Administration, Kansas City, Missouri. March 2013.

U. S. Census Bureau. 2010. American FactFinder, Community Facts, 2010 Census. Available at: http://www.census.gov/

APPENDIX A: MAPS



Map A-1. Vulnerable populations living near the former Hardesty Federal Complex site.



Map A-2. Sensitive populations living near the former Hardesty Federal Complex site.

APPENDIX B: ESTIMATED CANCER RISKS

Calculation of Estimated Increased Cancer Risks from Exposure to TCE former Hardesty Federal Complex site.

Increases in cancer risk from the inhalation of TCE in indoor air at two sampled residences were estimated assuming individuals have been exposed to the maximum TCE concentration detected in indoor air prior to VI mitigation.

Calculations are based on EPA's inhalation unit risk factors (IUFs) and age dependent adjustment factors (ADAFs). Table B-1 is the calculation spreadsheet for estimating the increased cancer risk from lifetime exposure to TCE, which takes into consideration higher early-life susceptibility to kidney cancer.

Estimated Cancer Risks of Inhalation of TCE:

Cancer Risk = Air Concentration × IUF × ADAFs

$$\text{Cancer Risk}_{(\text{high})} = 11\ \mu g/m^3 \times (4.1\times10^{-6}\ (\mu g/m^3)^{-1}) \times \text{ADAFs}$$

$$\text{Estimated Cancer Risk} = 5.2 \times 10^{-5}$$

Approximate Increase in Cancer Risk: 5 cases per 100 thousand people

Table B-1. Maximum Age-Specific Increased Cancer Risks from Exposure to TCE in Indoor Air

Age	Exposure Duration (adjusted)[a]	TCE conc.[b] ($\mu g/m^3$)	Kidney cancer unit risk factor[c]	ADAF[d]	**Kidney cancer partial risk[e]**	NHL & Liver cancer unit risk factor[f]	**NHL & Liver cancer Partial risk[g]**	**Total Partial Risk[h]**
Birth-<1mo	0.0012	11.0	1×10^{-6}	10	**1.3E-07**	3.1×10^{-6}	**4.1E-08**	**1.7E-07**
1-<3 mo	0.0024	11.0	1×10^{-6}	10	**2.6E-07**	3.1×10^{-6}	**8.1E-08**	**3.4E-07**
3-<6 months	0.0036	11.0	1×10^{-6}	10	**3.9E-07**	3.1×10^{-6}	**1.2E-07**	**5.1E-07**
6-<12 months	0.0071	11.0	1×10^{-6}	10	**7.9E-07**	3.1×10^{-6}	**2.4E-07**	**1.0E-06**
1-<2 yr	0.0143	11.0	1×10^{-6}	10	**1.6E-06**	3.1×10^{-6}	**4.9E-07**	**2.1E-06**
2-<3 yr	0.0143	11.0	1×10^{-6}	3	**4.7E-07**	3.1×10^{-6}	**4.9E-07**	**9.6E-07**
3-<6 yr	0.0429	11.0	1×10^{-6}	3	**1.4E-06**	3.1×10^{-6}	**1.5E-06**	**2.9E-06**
6-<11 yr	0.0714	11.0	1×10^{-6}	3	**2.4E-06**	3.1×10^{-6}	**2.4E-06**	**4.8E-06**
11-<16 yr	0.0714	11.0	1×10^{-6}	3	**2.4E-06**	3.1×10^{-6}	**2.4E-06**	**4.8E-06**
16-<18 yr	0.0286	11.0	1×10^{-6}	1	**3.1E-07**	3.1×10^{-6}	**9.7E-07**	**1.3E-06**
18-21 yr	0.0429	11.0	1×10^{-6}	1	**4.7E-07**	3.1×10^{-6}	**1.5E-06**	**1.9E-06**
21-30 yr	0.1286	11.0	1×10^{-6}	1	**1.4E-06**	3.1×10^{-6}	**4.4E-06**	**5.8E-06**
30-70 yr	0.5714	11.0	1×10^{-6}	1	**6.3E-06**	3.1×10^{-6}	**1.9E-05**	**2.6E-05**
Total Risk								**5.2E-05**

[a]Exposure duration (adjusted) = exposure duration (years) / lifetime (70 years)
[b]Maximum indoor air TCE concentration
[c]EPA 2011
[d]ADAF = age dependent adjustment factor
[e]Kidney cancer partial risk = exposure duration × concentration × kidney cancer unit risk factor × ADAF
[f]Non-hodgkins lymphoma (NHL) & liver cancer unit risk factor = NHL & liver & kidney unit risk factor – kidney cancer unit risk factor; NHL & liver & kidney unit risk factor = 4.1×10^{-6}
[g]NHL & liver cancer partial risk = exposure duration × concentration × NHL & liver cancer unit risk factor
[h]Total partial risk = kidney cancer partial risk + NHL & liver cancer partial risk.